PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or Relating to Apparatus for Controlling the Speed of a Main Piston in a Hydraulic Motor

We, ISLEF & HAGEN A/S, a Danish Company of Nyager 15, Glostrup, Denmark, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an apparatus for controlling the speed of a main piston in a working cylinder of a hydraulic motor each end of the cylinder communicating through a means with a directional valve by means of which one end of the working cylinder can be connected with a pressure source whilst the opposite end is connected to a pressureless outlet, and *vice versa*.

It is the object of the invention to provide an apparatus of the aforesaid kind, in which it is possible by very simple and reliable means to provide a control of the main piston so as to permit movements in the identical direction and in different directions at varying speeds. This is, for example, of importance if such a main piston is used for moving a saddle or carriage of a machine tool in which it is desired that one part of the movement is performed at high speed, whereas another part of the movement during which the work is carried out is performed at substantially lower speed.

In accordance with the invention the apparatus consists of a cylinder closed by end walls, the cylinder being arranged in one of the communicating means, a freely movable piston contained within the cylinder and adapted in any intermediate position between its two end positions to isolate the two end spaces of the cylinder one from the other, a passage through which the two cylinder end spaces communicate with each other controlled by valves which are arranged to operate such that when the piston takes up any intermediate position, the passage is closed and the end spaces of the cylinder isolated one from the other, whilst during the last part of the movement of the piston towards either end position the valves are actuated to open the passage to permit the flow of liquid therethrough in a direction towards said appropriate end, and wherein one cylinder end space communicates with the said one communicating means through two openings, a first one of which is provided with a throttle valve, whilst the second one of which is adapted to be closed by the movable piston when in the corresponding end position.

In a controlling apparatus formed in such manner the movable piston of the apparatus may at a part of the movement of the main piston move freely from one end of the cylinder to the other without influencing the mode of operation of the main piston, but when the freely movable piston reaches its end position, it will close the second outlet opening of the cylinder end and one of the valves provided in the connecting passage will be opened, after which the liquid flows through the passage and the throttle valve, thus involving a retardation of the movement of the main piston.

The amount of liquid, for example, oil displaced by the freely movable piston is independent of the adjustment of the throttle valve, and the free piston is always stationary in its end positions.

A very simple design is obtained if the passage connecting the two end spaces of the cylinder is provided in the movable piston, the valves being mounted at either end of the said passage and having means for co-operating with abutments provided on the two end walls of the cylinder.

According to a further feature of the invention at least one end wall may have an axially adjustable abutment which is adapted

[*Price 4s. 6d.*]

to engage pins provided on the valves of the piston.

In such a design the movements of the main piston may be varied by means of the said adjustable abutment and the throttle valve, so that the speed of the main piston may be finely controlled.

An embodiment of an apparatus according to the invention will now be described, by way of example, with reference to the drawing, in which

Figure 1 shows the apparatus in its starting position, and

Figures 2—5 show the same apparatus in various other positions.

In a working cylinder 1 is mounted a main piston 2 with a piston rod 3 connected, for example, with a carriage or slide of a machine tool. One end of the working cylinder 1 is connected with a directional valve 4 which communicates with a pipe 5 leading to a pressure source (not shown) and with a pipe 6 leading to a pressureless outlet. The pipe connecting the working cylinder 1 and the directional valve 4 is denoted by 7.

The other end of the working cylinder 1 communicates through a pipe 8 with a passage 9 in the end wall 10 of a cylinder 11, the other end wall 12 of which has an opening 13 communicating through a pipe 14 with the directional valve 4.

In the cylinder 11 is mounted a free piston 15 containing a hollow space 16 which communicates through passages 19 and 20 with the two cylinder spaces 17 and 18 which are separated from each other by the piston. In the said passages 19 and 20 are mounted pins 21 and 22 carrying ball-shaped valve bodies 23 and 24 which are subjected to the action of a coil spring 25 urging the valve bodies against inwardly facing valve seats in the passages 19 and 20.

The piston 15 is provided with a bore 26 adapted to receive a conforming abutment or projection 27 formed on the end wall 12. Through the said projection 27 there extends an opening 28 which communicates with the opening 13 and has a throttle valve 29 by means of which the flow area may be varied.

The pin 21 is adapted to be acted upon by a bar-shaped control member 30 which extends through the end wall 10 and may be adjusted by means of a handle 31. The pin 22 is adapted to engage the inwardly facing surface of the projection 27.

The apparatus operates in the following manner: In the starting position shown in Figure 1 the pipe 14 contains a pressure liquid, the pressure of which is transmitted through the opening 13 to the space 18 and through the passage 20, space 16, and passage 19, which is open, the control member 30 keeping the valve body 23 away from its seat, and the valve body 24 is opened by the pressure. The pressure may then be transmitted to the space 17 and through the pipe 8 to the right-hand side of the main piston 2 of the working cylinder 1, so that the piston 2 is kept in its left-hand outer position. If, now, the directional valve 4 is acted upon so that a pressure arises in the pipe 7, whereas the pipe 14 is brought into communication with the outlet, a pressure will be produced in the left-hand end of the working cylinder 1 and the main piston 2 will move to the right in the direction of the arrow *a* (Figs. 2 and 3). The liquid in the right-hand side of the main cylinder 1 will be forced through the pipe 8 into the space 17 and move the piston 15 in the direction of the arrow *b*. As soon as the rod 21 is clear of the control member 30, the valve body 23 is urged against its seat by the spring, and the valve body 24 is forced against its seat by the liquid pressure, after which the passage through the piston is blocked. The piston will thus be passed as a closed piston towards the end wall 12 and the liquid in the space 18 will be forced out through the opening 13 into the pipe 14 and hence to the outlet pipe 6.

Figure 3 shows the piston 15 in its end position, in which the pin 22 has been moved to the left by striking the projection 27 so that the valve body 24 has been removed from its seat. In this position the main piston 2 has moved a distance x in the working cylinder 1, whereas the piston 15 has moved a distance z (Fig. 1) the length of which is determined by that liquid volume which has left the working cylinder 1 and has been received in the cylinder 11.

When the directional valve 4 remains in the position indicated in Figures 2 and 3, pressure liquid will continue flowing into the working cylinder 1 and the piston will continue its movement in the direction of the arrow *a* from the position indicated in Figure 3. The liquid discharged from the working cylinder 1 through the pipe 8 flows into the space 17 and forces the valve body 23 from its seat so that the liquid may flow through the piston, but in the position indicated in Figure 3 the liquid cannot be discharged through the opening 13 which is closed by the piston 15, and the liquid will thus have to be discharged through the opening 28 and thus be subjected to throttling. This will reduce the velocity of the liquid flow and consequently the speed of the piston 2.

In this manner the main piston 2 may move a desired distance f while the piston 15 is inoperative, for example to the position y indicated by dotted lines.

When the main piston is to be returned, the directional valve is again changed over to the position indicated in Figures 1 and 4, and pressure liquid is now passed through the pipe 14 into the space 18, after which

the piston 15 is moved to the left in the direction of the arrow *c*. As soon as the piston 15 has left the end wall 12, the passage through the piston is closed, and the piston is now passed to the left as a closed piston, during which movement the liquid flows from the space 17 through the pipe 8 into the right-hand end of the working cylinder 1, thereby moving the main piston 2 to the left in the direction of the arrow *d*. This movement is performed at full speed and continues until the pin 21 engages the control member 30, after which the condition illustrated in Figure 1 has been reached as far as the controlling apparatus is concerned, whereas the main piston 2 has not yet got back into its starting position as appears from Figure 5. The main piston 2 is returned while the piston 15 is inoperative, the pressure liquid being passed through the passage provided in the said piston as indicated by the arrows *e* in Figure 5. At the end of this movement the main piston reaches its starting position as shown in Figure 1, and a new cycle of operation may be commenced.

WHAT WE CLAIM IS:—

1. An apparatus for controlling the speed of a main piston in a working cylinder of a hydraulic motor, each end of the cylinder communicating through means with a directional valve by means of which one end of the cylinder can be connected to a pressure source whilst the opposite end is connected to a pressureless outlet and *vice versa*, the apparatus comprising a cylinder closed by end walls, the cylinder being arranged in one of the communicating means, a freely movable piston contained within the cylinder and adapted in any intermediate position between its two end positions to isolate the two end spaces of the cylinder one from the other, a passage through which the two cylinder end spaces communicate with each other controlled by valves which are arranged to operate such that when the piston takes up any intermediate position, the passage is closed and the end spaces of the cylinder isolated one from the other, whilst during the last part of the movement of the piston towards either end position the valves are actuated to open the passage to permit the flow of liquid therethrough in a direction towards said appropriate end, and wherein one cylinder end space communicates with the said one communicating means through two openings a first one of which is provided with a throttle valve, whilst the second one of which is adapted to be closed by the movable piston when in the corresponding end position.

2. An apparatus as claimed in claim 1, wherein the passage connecting the two cylinder end spaces is provided in the movable piston, the valves being mounted at either end of the passage and being provided with means for cooperating with abutments in the two end walls of the cylinder.

3. An apparatus as claimed in claim 2 wherein the valves have valve bodies cooperating with inwardly facing valve seats in the passage, the said valve bodies being in engagement with a spring adapted to urge them against their seats, and wherein the means comprise projecting pins adapted to strike against the abutments provided on the end walls.

4. An apparatus as claimed in claim 3, wherein at least one end wall has an axially adjustable abutment which is adapted to engage the adjacent pin provided on the adjacent valve body.

5. An apparatus as claimed in any one of claims 2 to 4, wherein the second opening is provided eccentrically on one end wall of the cylinder and that a centrally disposed inwardly projecting abutment on said end wall adapted to be received in a corresponding depression on the movable piston is provided with the first opening controlled by the throttle valve, the second opening connecting the adjacent end space of the cylinder with the first opening.

6. An apparatus for controlling the speed of a main piston in a working cylinder of a hydraulic motor, constructed arranged and adapted to operate substantially as hereinbefore described with reference to and as illustrated in the Figs. of the accompanying drawings.

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Agents for the Applicants.

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Fig. 1

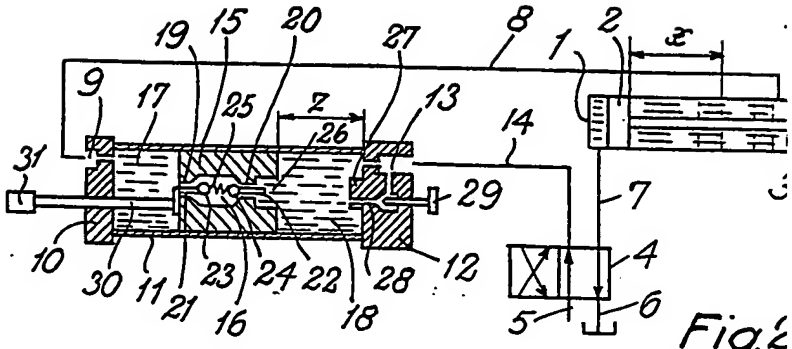


Fig. 2

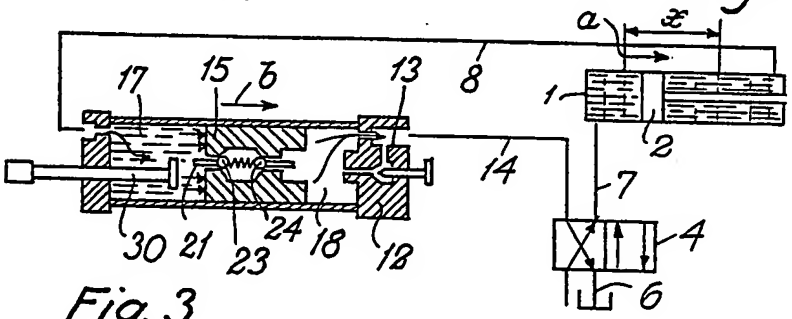
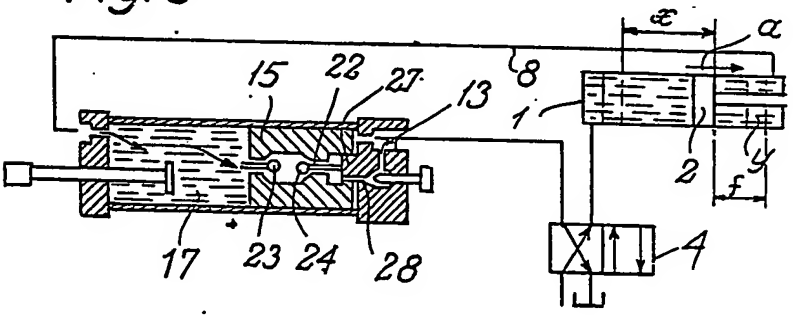


Fig. 3



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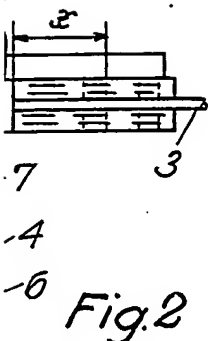
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

Fig. 4



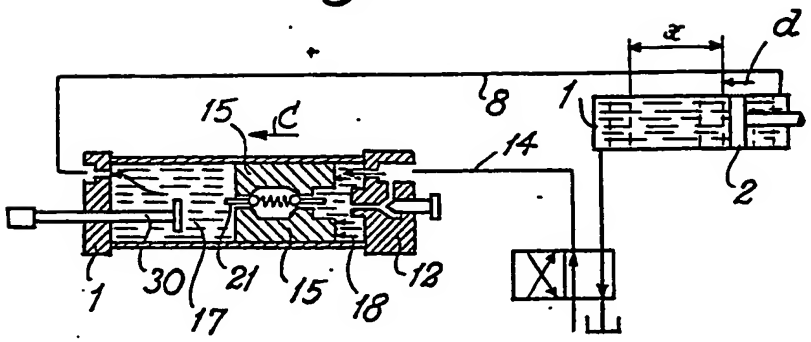


Fig. 2

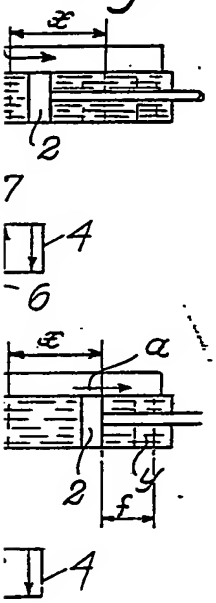
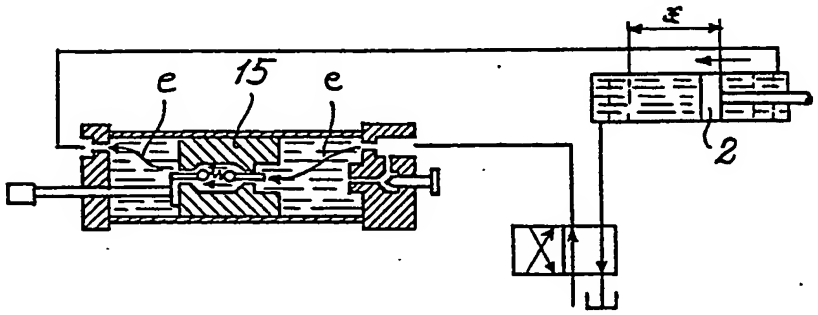


Fig. 5



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Sheets 1 & 2

Fig. 1

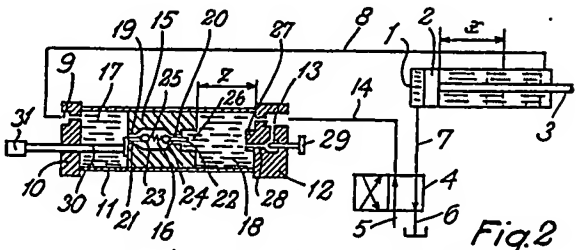

Fig. 2

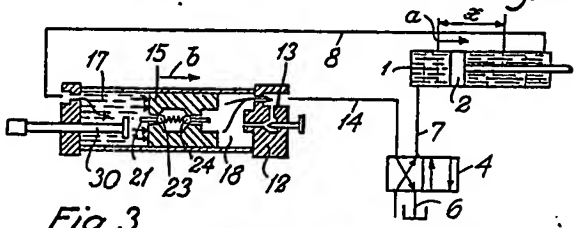

Fig. 3

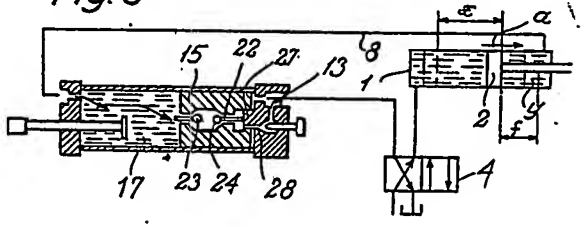

Fig. 4

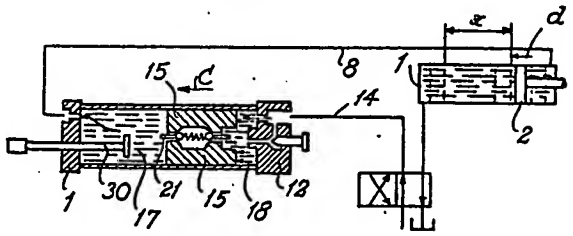

Fig. 5